PROFESSIONAL DEVELOPMENT
SEMINAR SERIES

GPS-170 ENGINES & ALTERNATORS

LEARNER'S GUIDE

GENERAC® | INDUSTRIAL POWER

WELCOME

Professional Development Seminar Series

Standby power systems are increasingly in demand. Commercial, industrial, municipal and healthcare facilities are just a few of the markets that require backup power. Engines and alternators are crucial components for these systems.

The ever-changing requirements of the power generation industry, coupled with requests for additional training, has prompted Generac Power Systems to develop this training program.

Titled the Generac Power Systems Professional Development Seminar Series, this program consists of individual training modules that provide both theoretical and practical information. Each module is 90 minutes in length and each incorporate proven learning methodology to ensure a positive experience. These modules are designed to broaden the learner's understanding of topics such as:

- Current Technologies
- Sizing
- Codes & Standards
- Switching Technologies
- Reliable Design Characteristics
- Paralleling
- Engines and Alternators
- Controls
- Emissions

THE MODULE IN PERSPECTIVE

PURPOSE:

This course introduces engines and engine technologies used in the design and implementation of standby power generation. Terminology and engine theory will be discussed along with selection criteria, optimization and validation testing. In the alternator section you'll learn how a voltage can be produced by moving a wire through a magnetic field. The main components of an alternator will be described along with the various construction practices used during manufacturing. Wiring differences will also be covered describing the differences between Wye and Delta configurations.

TIME:

- 90 minutes of Classroom Instruction
- 30 minutes for Final Assessment

LEARNING OBJECTIVES:

Upon completion of this seminar, participants should be able to:

- Describe the basic operation of an engine
- List and explain different types of fuel injection systems
- Describe the performance effects of turbo-charging
- Explain bi-fuel operation
- Describe Generac's criteria for engine selection and optimization
- Explain different methods for achieving power optimization
- Explain the relationship between torque and RPM for diesel and automotive engines
- Describe BMEP (break mean effective pressure) relative to engine stress
- List and describe the main components of an alternator
- Describe how the interaction of the stator and rotor can produce a voltage
- Explain how frequency is affected by the number of poles and RPM
- Explain the differences between Wye and Delta configurations
- Describe skew and pitch construction
- Describe voltage regulator operation
- Explain the differences between direct and brushless excitation

CONTINUING EDUCATION:

Upon successful completion of this seminar, participants will be awarded a certificate of achievement identifying the seminar title, 2.0 PDHs (Professional Development Hours) and 0.2 CEUs (Continuing Education Units).
Successful completion of a PDSS seminar requires that the participant have:

1. Attended the complete seminar
2. A minimum score of 80% on the Final Assessment

TRAINING AT A GLANCE

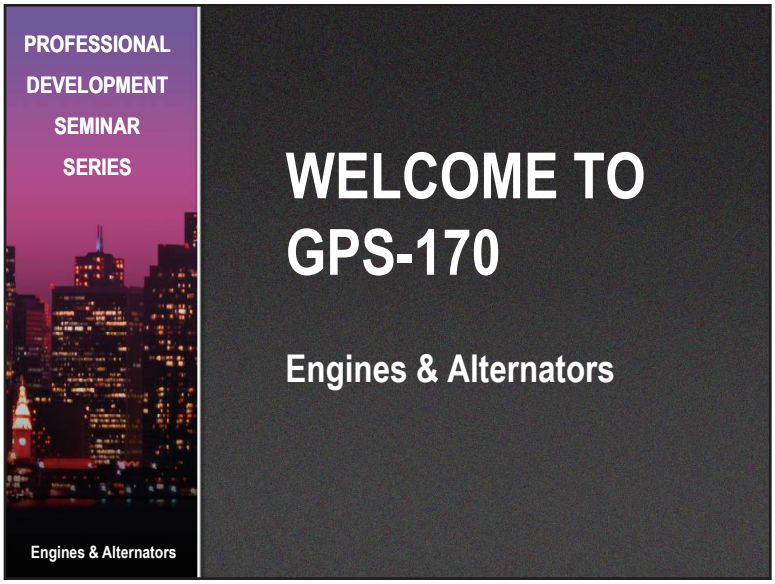
TIME	LESSON	DESCRIPTION
5 minutes	Introductions	Get to know other participants and the trainer. The trainer welcomes participants and conducts an opening activity.
25 MINUTES	LESSON 1 Engine Overview	Basic engine operation will be explained along with various performance components including fuel injection, turbo-chargers, governors and charge-air-cooling. Factors involved in rating and de-rating engines for generator use will also be discussed.
25 MINUTES	LESSON 2 Engine Selection and Optimization	Criteria for proper engine selection are discussed along with Generac's specific requirements for engine optimization. Torque and RPM relationships are explained relative to diesel and automotive engines along with stress related factors. Prototype and production testing is also discussed.
30 Minutes	Lesson 3 Alternators	Beginning with a review of alternator theory, you'll learn how a voltage can be produced by moving wire through a magnetic field. The main components of an alternator will be described along with the various construction practices used during manufacturing. Wiring configurations will also be covered describing the differences between Wye and Delta configurations.
5 minutes	Conclusion	The trainer will review the objectives of the class and discuss how each objective was accomplished. An evaluation will be given out with which participants can provide feedback about the course. An assessment will also be given to each participant to evaluate the skills and knowledge they received from the course.

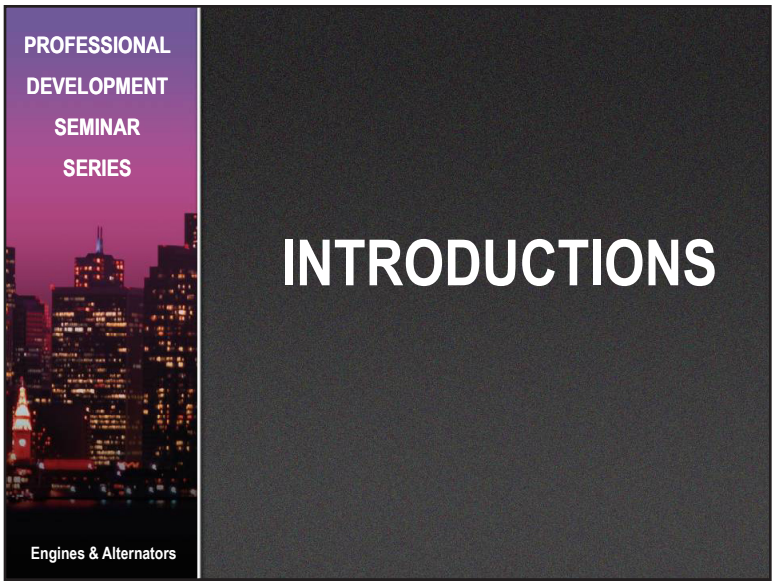
INTRODUCTION

TIME: 5 minutes

OBJECTIVE:

The introduction is an opportunity for the trainer and participants to become familiar with each other. This period will discuss the topics to be covered, capture initial questions and introduce engines and alternators.





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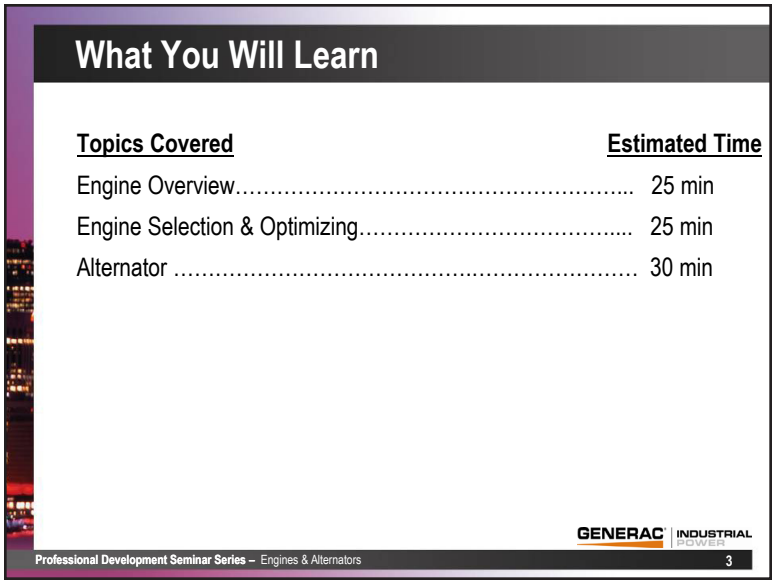
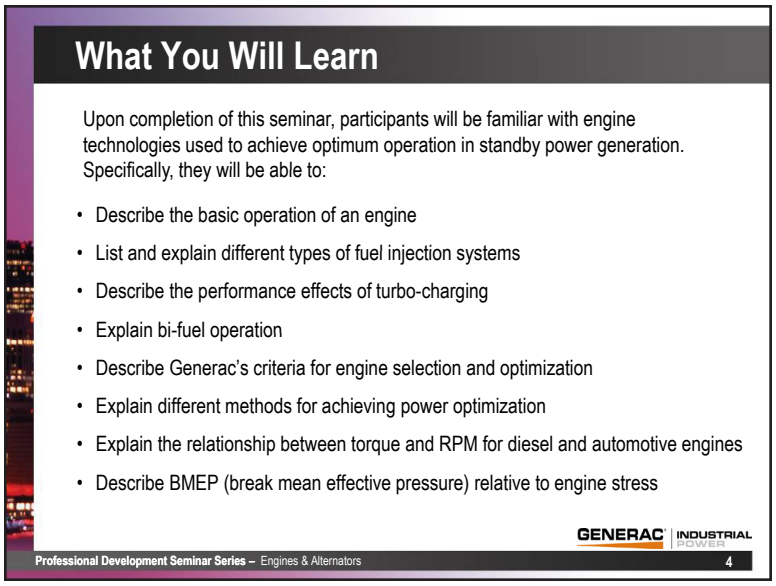
INTRODUCTION





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What You Will Learn

Upon completion of this seminar, participants will be familiar with alternators. Specifically, they will be able to:

- List and describe the main components of an alternator
- Describe how the interaction of the stator and rotor can produce a voltage
- Explain how frequency is affected by the number of poles and RPM
- Explain the differences between Wye and Delta configurations
- Describe skew and pitch construction
- Describe voltage regulator operation
- Explain the differences between direct and brushless excitation

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Engine Trivia

- **Worlds largest engine**
  - What's it's horsepower?
  - How many cylinders?
  - Who makes it?
  - What is its design application?

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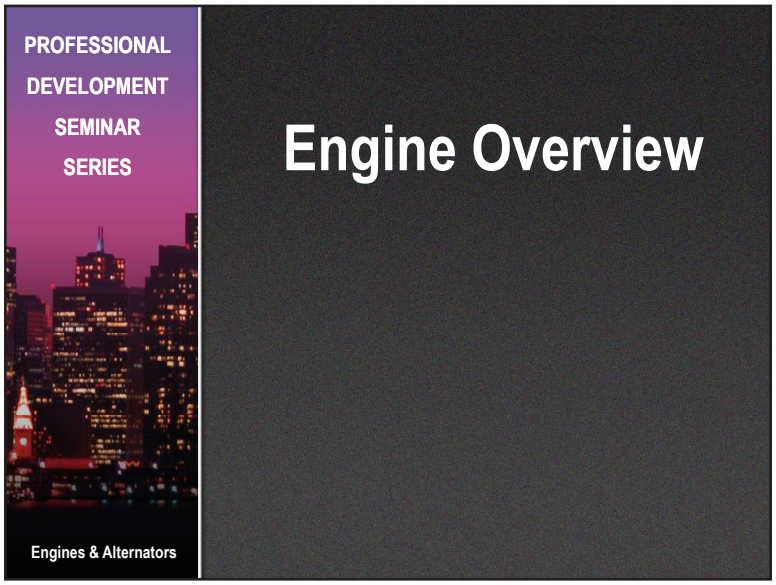
1. ENGINE OVERVIEW

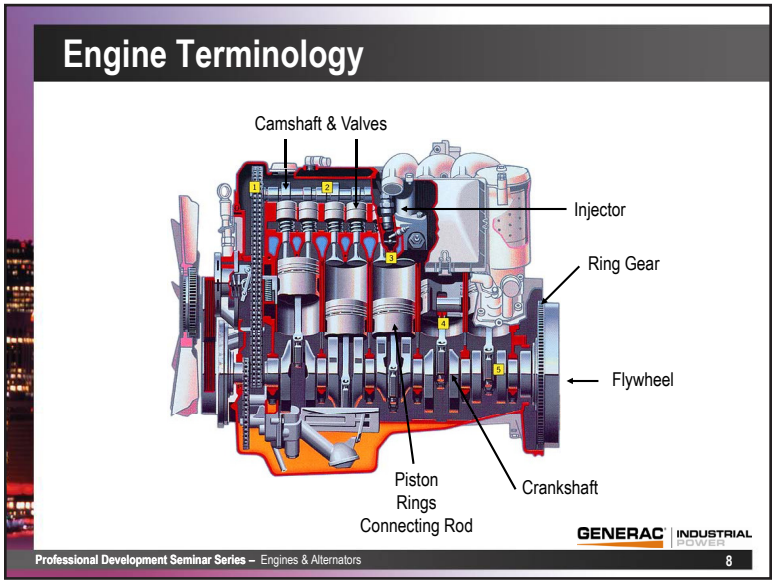
TIME: 25 minutes

OBJECTIVES:

Upon completion of this lesson, participants should be able to:

- Describe the basic operation of an engine
- List and explain different types of fuel injection systems
- Describe the performance effects of turbo-charging
- Explain bi-fuel operation





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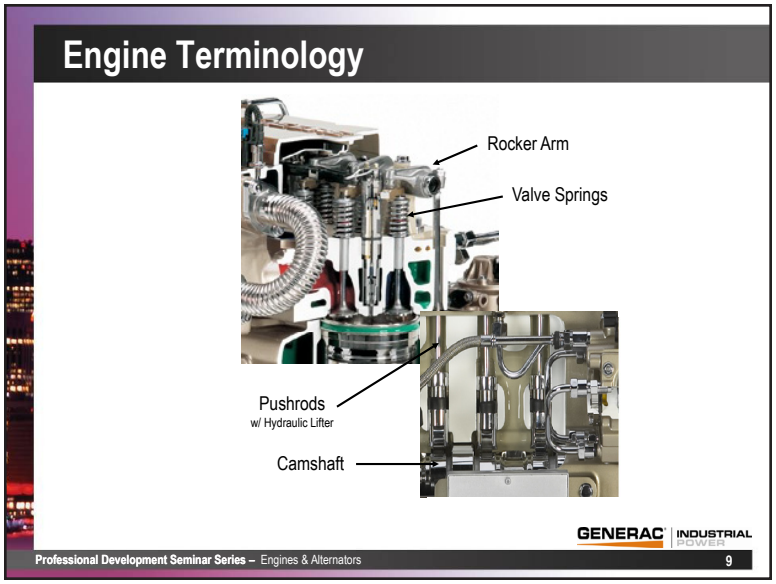
Engine Terminology
Rocker Arm
Valve Springs
Pushrods
w/ Hydraulic Lifter
Camshaft
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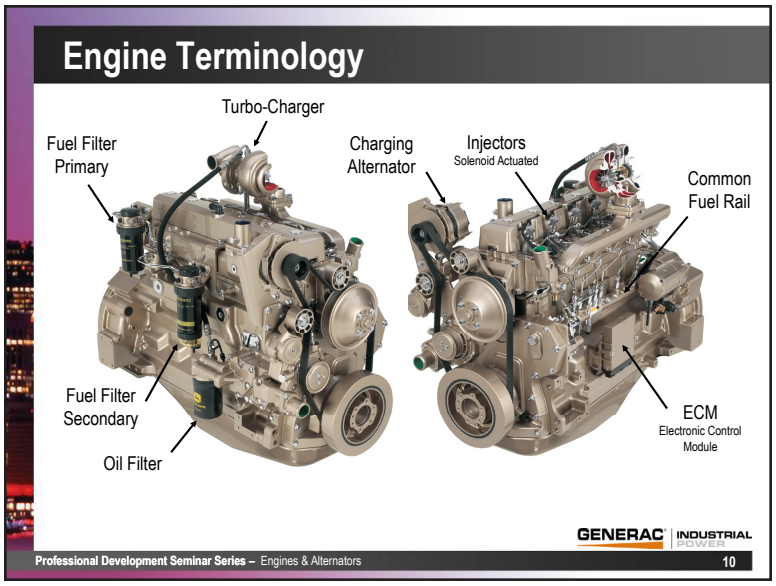
Engine Terminology
Turbo-Charger
Fuel Filter
Primary
Charging
Alternator
Injectors
Solenoid Actuated
Common
Fuel Rail
Fuel Filter
Secondary
Oil Filter
ECM
Electronic Control
Module
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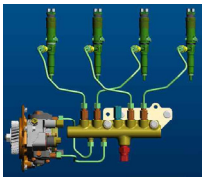
NOTES

Injection Technology

- **Mechanical**
  - Simple and reliable
  - Emission limited
- **Electronic**
  - Good emissions
  - Good start-ability
  - Good block loading
  - Circuit board and solenoid control
    - Number of injections
    - Injection pressure
    - Start of injection
    - Duration of injection
    - End of injection



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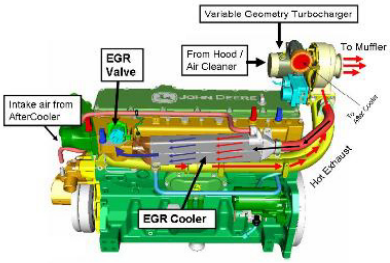
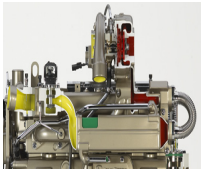
Engine Terminology





Turbo-charger
- Compresses incoming air
- Increases engine power

EGR (Exhaust Gas Recirculation)
- Exhaust gas (10 – 30%) redirected to intake
- Lowers emissions (tier 3)

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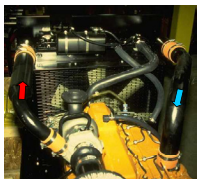
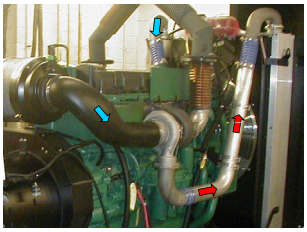
NOTES

Engine Terminology

- **Charge-air-cooling**
  - Cools turbo-charger compressed air
  - Air-to-air after coolers
  - Inter-coolers
  - Inter-coolers with separate radiator core





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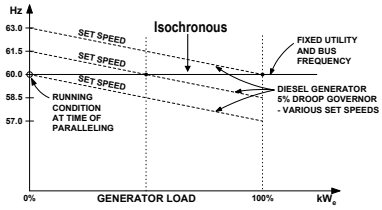
Engine Terminology

- **Governor**
  - Controls speed of the engine
  - Typically integrated into the ECM
  - Historically
    - Mechanical for small diesels
    - Electronic for larger diesels

(circuit board & actuator)



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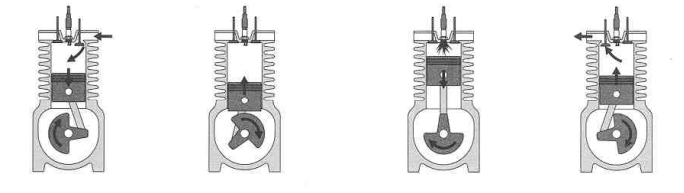
NOTES

1. ENGINE OVERVIEW

Engine Theory

4 Stroke (Cycle)

– One cycle is 2 crankshaft revolutions (4 strokes)



INTAKE STROKE | COMPRESSION STROKE | POWER STROKE | EXHAUST STROKE

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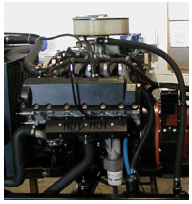
Gas Versus Diesel

- **Diesel engines**
  - Directly inject the fuel into the cylinder
  - Heat of compression ignites the fuel
  - High compression engines 15-20 to 1 ratio
  - Standard for large kW applications (+150 kW)

- **Spark-ignited engines**
  - Pre-mix air and fuel (carburetion)
  - Use a spark plug to ignite the fuel
  - Common in small kW applications (-150 kW)
  - No fuel maintenance
  - Long run times



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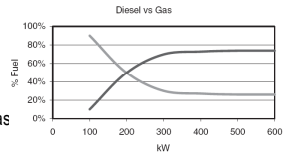
NOTES

Bi-fuel (Gas and Diesel)

- **Simultaneous combustion of two fuels**
  - Diesel & natural gas
  - Compression ignited engine
  - Diesel is the igniter (pilot fuel)
  - Up to 75% of the energy comes from the natural gas
- **Engine can run 100% diesel**
- **Engine cannot run on 100% gas**
- **Extends on-site diesel by a factor of 3.5**



Diesel vs. Bi-Fuel™ Run Times
(600 kW genset at 75% load)

Diesel Tank Capacity	Diesel-Only Run Time	Bi-Fuel™ Run Time
20" tall / 469 gallons	10 hours	33 hours (1.3 days)
30" tall / 936 gallons	20 hours	66 hours (2.7 days)
40" tall / 1349 gallons	29 hours	94 hours (3.9 days)

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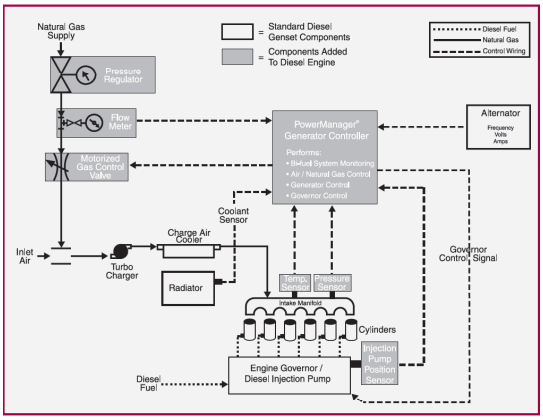
Bi-fuel (Gas and Diesel)



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NOTES

Ratings

- **Standby**
  - Backing up a reliable, normal (typically utility) source
  - Operates for the duration of the power outage
  - Average load level should be less than 80% of the standby rating
  - No overload capacity
- **Prime power**
  - The generator is the primary source of power
  - Typically rated at 90% of the standby rating
  - The average load should be 70% of the prime power rating (63% of standby rating)
  - Overload capacity available
- **Continuous**
  - Rating used for grid base loading or cogeneration
  - Load levels are fixed instead of variable
  - Typical rating is 60-65% of the standby rating

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De-rating

- **Ambient**
  - Check manufacturer data sheets
  - Check the fine print
    - SAE J1349 or ISO 3046 default to 77°F unless otherwise specified
    - Radiator temperature rating is not the same as the engine
- **Altitude**
  - Check manufacturer data sheets
  - Spark-ignited engines tend to de-rate more than diesels
  - Typical de-rate is 3300 feet
- **Fuel**
  - Small spark-ignited engines may use an LP rating and de-rate on natural gas
  - Land-fill gas typically has low BTU value and results in a de-rate
  - Diesels can de-rate with an increase in fuel temperature
  - Diesels can de-rate on blended fuels (lower BTU value)

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NOTES

Fuels

- **Land-fill methane & well head gas**
  - Consult manufacturer
  - Gas quality may be a constraint
    - BTU value
    - Corrosive elements in fuel
- **Bio-diesel**
  - Fuel does not store well for standby applications
  - Most manufacturers currently limit usage to 5% (95/5)
    - Consistency of fuel
    - Affects on injection system components

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Trends

- **Increased power density**
  - Better materials
  - Better computer modeling
  - Electronic injection systems
- **Improved performance**
  - Variable pitch turbo-chargers
  - Electronic injection
- **Larger engines (1800 RPM)**
  - Suppliers adding cylinders and increasing bore
  - Large natural gas engines moving toward 1800 RPM
- **Long lead times on large block engines**

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NOTES

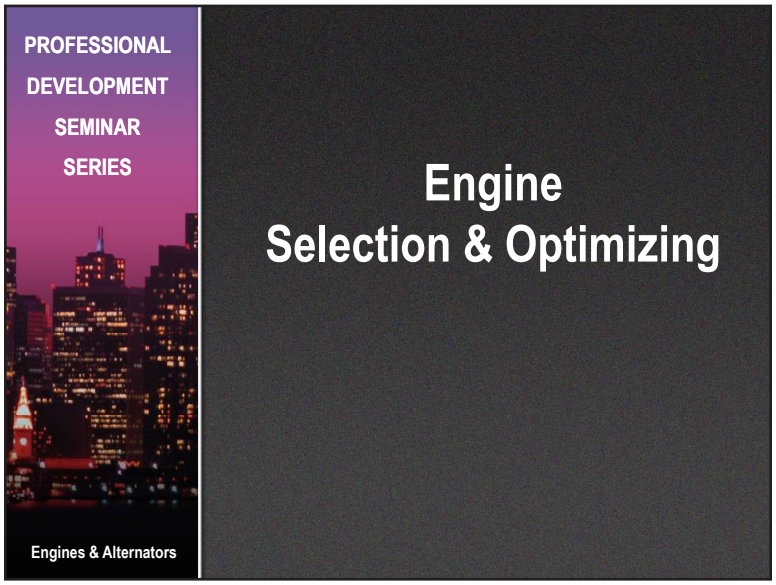
2. ENGINE SELECTION AND OPTIMIZATION

TIME: 25 minutes

OBJECTIVES:

Upon completion of this lesson, participants should be able to:

- Describe Generac's criteria for engine selection and optimization
- Explain different methods for achieving power optimization
- Explain the relationship between torque and RPM for diesel and automotive engines
- Describe BMEP (break mean effective pressure) relative to engine stress



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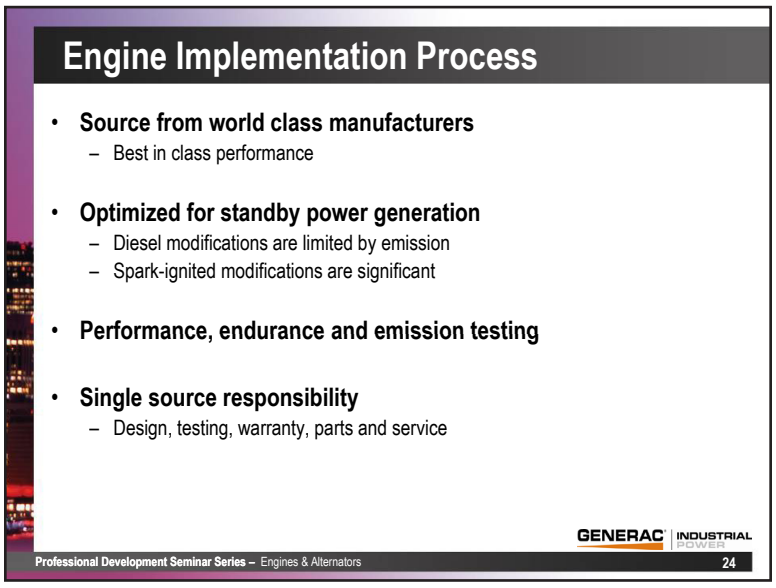

Engine Suppliers

- **Diesel suppliers**
  - Caterpillar
  - Cummins
  - Deutz
  - Doosan Engine
  - John Deere
  - Man Engine
  - Mitsubishi
  - Mercedes Benz
  - MTU / DDC
  - Perkins
  - Volvo
  - Wartsilla

- **Gas suppliers**
  - Caterpillar
  - Ford
  - GM
  - Guascor
  - GE Jenbacher
  - Waukesha Engine

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Engine Globalization

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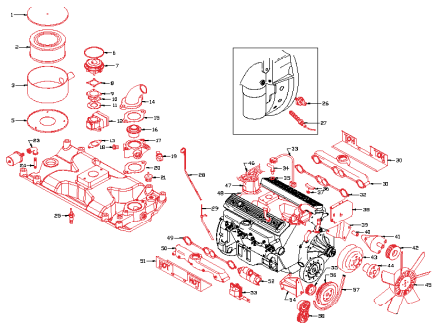
NOTES

2. ENGINE SELECTION AND OPTIMIZATION

Engine Optimization

- **Most spark-ignited engines** (Engines under 225 hp)
  - Designed and refined for on-highway
  - Produced in volume
  - Proven quality
  - Proven durability
  - Cost effective



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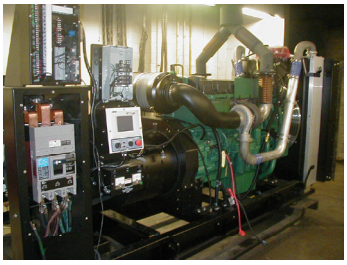
Engine Testing

- **Prototype testing**
  - Power
  - Heat runs
  - Transient
  - Torsional
  - Endurance
  - Emissions (EPA)
  - UL2200



- **Production testing**
  - Full load test
  - Transient performance
  - Frequency and voltage optimized

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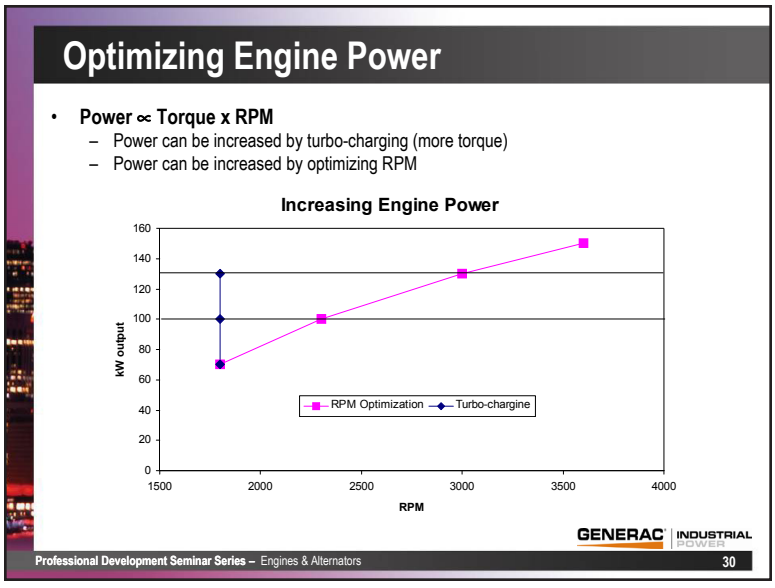
NOTES

2. ENGINE SELECTION AND OPTIMIZATION



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Optimizing Engine Power

- **What limits an automotive engine's life in standby power?**
  - Bearing stress (or)
  - Cylinder lining and valve wear
- **Do you down shift when towing a large load up a steep grade?**
- **Diesel engines are designed for high torque low RPM**
  - High compression engine with large bearings
  - Turbo-chargers increase engine torque & power
- **Automotive engines are designed for low torque and higher RPM**
  - Low compression engine with modestly sized bearings
  - Power is typically gained through increasing RPM

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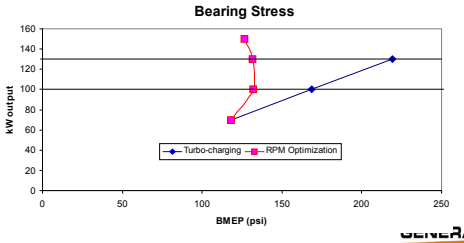
Lower BMEP

- **BMEP (break mean effective pressure)**
  - Average effective pressure placed on a piston during a complete cycle
  - How hard the bottom end of the engine is working
    - Wrist-pins, connecting rods, crank, bearings and head gaskets
  - BMEP = $\frac{792{,}000 \times BHP}{RPM \times Displacement}$

Increasing RPM reduces stress on the engine



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NOTES

Less Bearing Stress

- **Comparison of the two configurations**
  - Turbo-charging increases bearing stress by 45%

125 kW Piston Pressure & Bearing Loading Comparison

Engine Configuration	Engine RPM	BMEP (psi)	Bearing Load Peak (psi)
6.8L natural gas no turbocharger	3000	116	2850
8.1L natural gas, turbocharged, after-cooled	1800	168	4144

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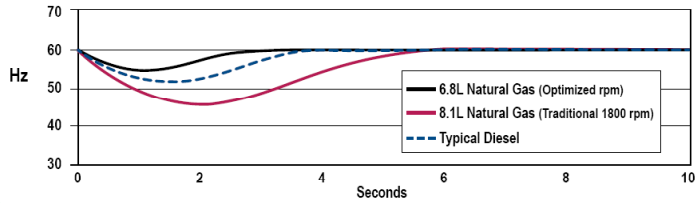
Better Block Loading

- **Engine rotational energy is proportional to speed squared**
  - Increasing speed to 3000 rpm equates to 177% increase in energy
    - Better block loading
    - Better motor starting
    - Better frequency regulation (tighter power system)

125 kW Block Load, Transient Performance Data



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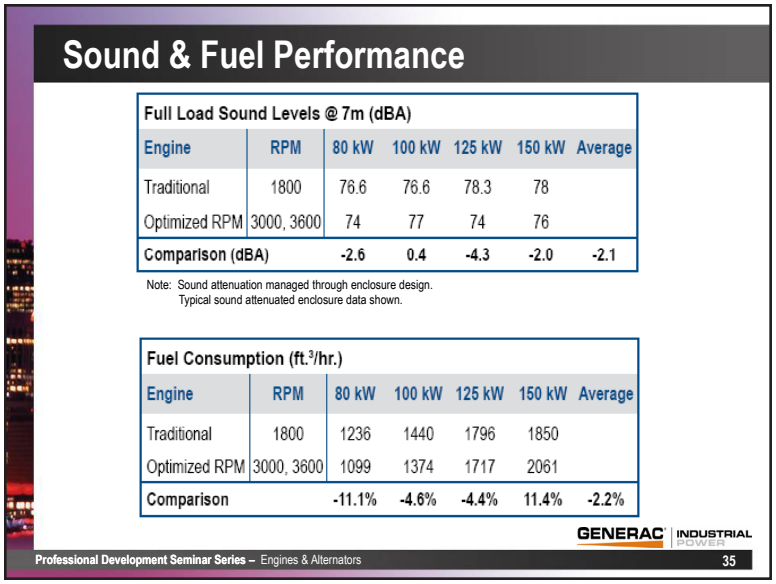

Sound & Fuel Performance

Full Load Sound Levels @ 7m (dBA)

Engine	RPM	80 kW	100 kW	125 kW	150 kW	Average
Traditional	1800	76.6	76.6	78.3	78	
Optimized RPM	3000, 3600	74	77	74	76	
Comparison (dBA)		**-2.6**	**0.4**	**-4.3**	**-2.0**	**-2.1**

Note: Sound attenuation managed through enclosure design.
Typical sound attenuated enclosure data shown.

Fuel Consumption (ft.^{3}/hr.)

Engine	RPM	80 kW	100 kW	125 kW	150 kW	Average
Traditional	1800	1236	1440	1796	1850	
Optimized RPM	3000, 3600	1099	1374	1717	2061	
Comparison		**-11.1%**	**-4.6%**	**-4.4%**	**11.4%**	**-2.2%**

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NOTES

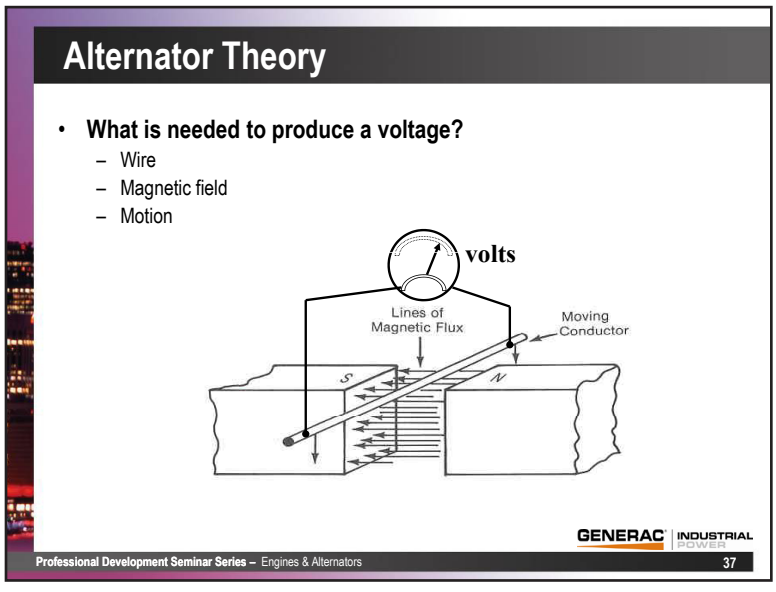
3. ALTERNATORS

TIME: 30 minutes

OBJECTIVES:

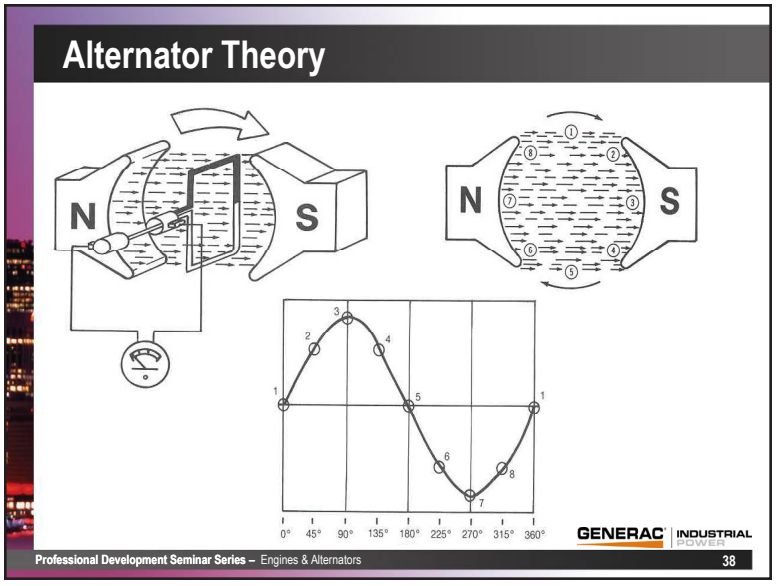
Upon completion of this lesson, participants should be able to:

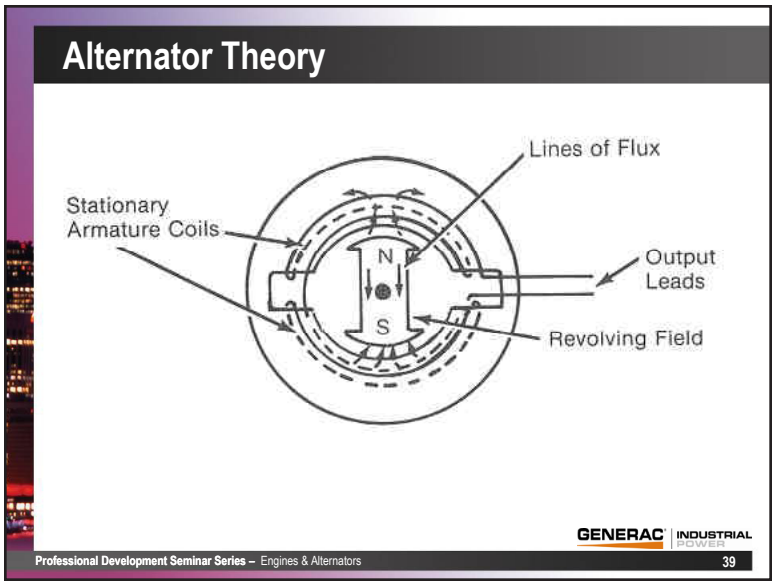
- List and describe the main components of an alternator
- Describe how the interaction of the stator and rotor can produce a voltage
- Explain how frequency is affected by the number of poles and RPM
- Explain the differences between Wye and Delta configurations



NOTES

3. ALTERNATORS





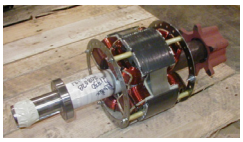
NOTES

3. ALTERNATORS

Alternator Component Terminology

Geometry

- **Rotor**
  - Part (winding) that rotates
- **Stator**
  - Part that is stationary



Function

- **Field**
  - Part that inputs the magnetism
- **Armature**
  - Part that generates output voltage
  - "Wire"

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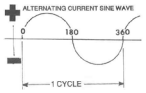
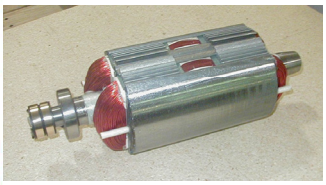
Alternator Frequency

- **What determines the alternator frequency?**
  - RPM
    - Governor / engine speed
  - Poles
    - Field design
  - F = $\frac{\text{RPM x Pole}}{120}$



60 Hertz		50 Hertz	
Poles	RPM	Poles	RPM
2	3600	2	3000
4	1800	4	1500
6	1200	6	1000
8	900	8	750



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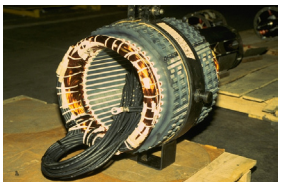
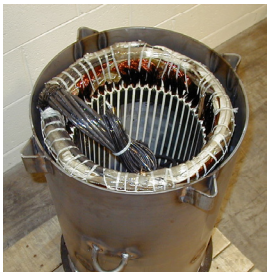
NOTES

Alternator Voltage

- **What determines the alternator voltage?**
  - Excitation strength
    - Voltage regulator
  - Main stator winding configuration
    - Design voltage
    - Winding connections (12 lead)





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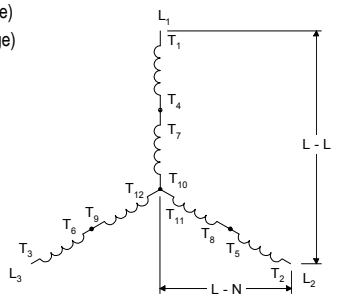
Alternator Voltage

- **High wye connection**
  - L-L (480 – 416V workable coil range)
  - L-N (277 – 208V workable coil range)

LL	LN
480	277
416	240



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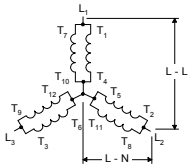
Professional Development Seminar Series – Engines & Alternators 43

NOTES

Alternator Voltage

- **Low wye connection**
  - L-L (240 – 208V workable coil range)
  - L-N (139 – 120V workable coil range)

LL	LN
240	139
208	120



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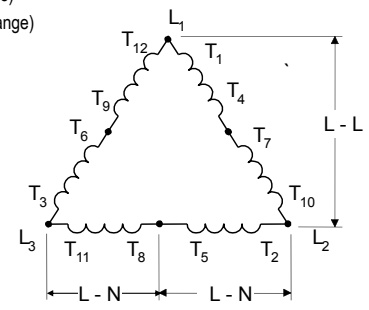
Alternator Voltage

- **High delta connection**
  - L-L (240 – 208V workable coil range)
  - L-Tap (139 – 120V workable coil range)

LL	LN
240	120/208



Note: The center tap is not a true neutral because it is not the same potential to all line conductors.

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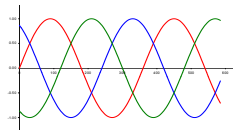
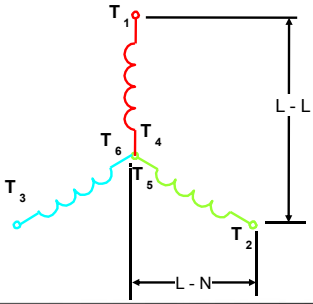
NOTES

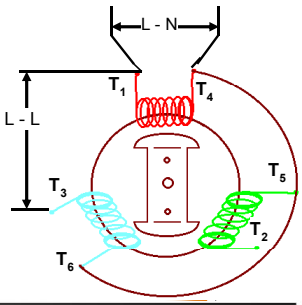
3. ALTERNATORS

Alternator Phase

- **What determines the number of phases?**
  - Main stator winding configuration
    - Single phase
    - Three phase
      - Three single phase coils (interconnected)



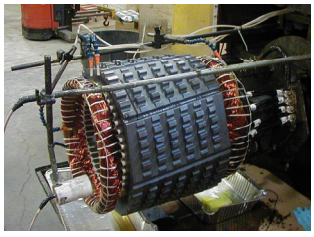




Professional Development Seminar Series – Engines & Alternators 46

Main Stator – Stationary Armature

- **Main stator construction**
  - Laminations
  - Cooling passages
  - Skewed stack - minimizes slot ripple on output voltage (no slot ripple)
  - 2/3 pitch - minimizes harmonics on output voltage (no third harmonic)
  - Varnishing
    - Repeatable / automated process
    - Dip & bake
    - Trickle varnish
    - Vacuum pressure impregnation (VPI)



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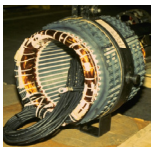
Professional Development Seminar Series – Engines & Alternators 47

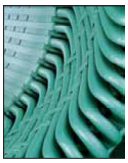
NOTES

Main Stator – Stationary Armature

- **Main stator construction**
  - Random wound
    - Market norm
    - Good durability
    - Cost effective
    - Good motor starting



  - Form wound
    - Coils wrapped in insulating tape & then VPI
    - Excellent environmental durability
    - Twice the cost of random wound generators
    - Poor motor starting
    - Abrasive, corrosive, and saturated salt water environments



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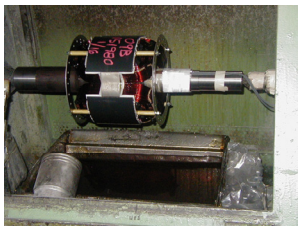
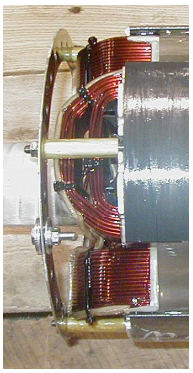
Professional Development Seminar Series – Engines & Alternators 48

Main Rotor – Rotating Field

- **Main rotor construction**
  - Amortisseur windings
  - Precision winding
  - Double venting
  - Repeatable varnish process





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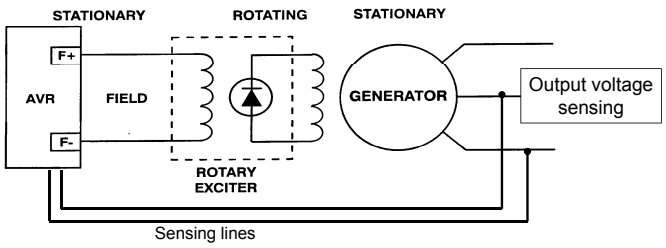
Professional Development Seminar Series – Engines & Alternators 49

NOTES

Voltage & Excitation Control

- **What does the voltage regulator do?**
  - **Controls power to the exciter stator (field)**
    - Monitors alternator output
    - Controls alternator output



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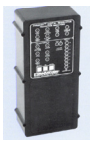
Professional Development Seminar Series – Engines & Alternators 50

Voltage & Excitation Control

- **Typical analog regulator**
  - Regulation: 1.0%
  - Single phase, peak sensing
  - Volts / Hertz (U/F protection)



- **Typical digital regulator**
  - Regulation: 0.25%
  - Three phase, RMS sensing
  - Engine unloading algorithms
  - Integrated (based on manufacturer)

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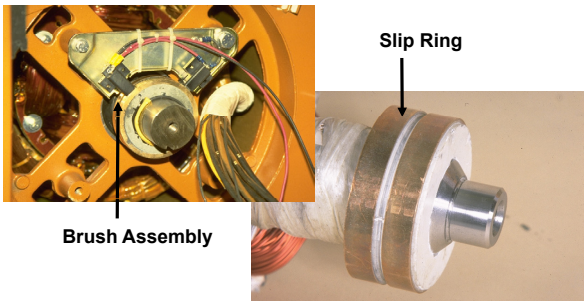
Professional Development Seminar Series – Engines & Alternators 51

NOTES

Voltage & Excitation Control

- **What is direct excitation?**
  - Brushes and slip rings
  - Common on small commercial generators (<40 kW)



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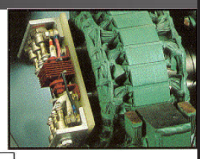
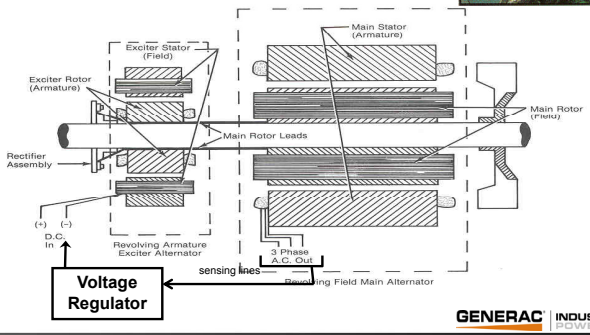
Professional Development Seminar Series – Engines & Alternators 52

Voltage & Excitation Control

- **What is a brushless exciter?**
  - Stationary field, revolving armature alternator
  - Powers the main rotor
  - Replaces brushes and slip rings





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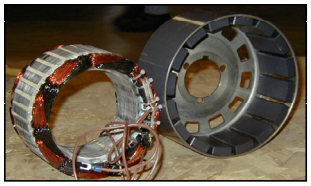
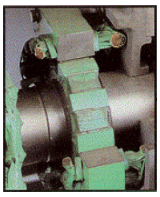
Professional Development Seminar Series – Engines & Alternators 53

NOTES

Voltage & Excitation Control

- **What powers the voltage regulator?**
  - Permanent Magnet Generator (PMG)
    - Independent power source to regulator
    - Better noise immunity
    - Fault current (300%)
    - Standard above150 kW





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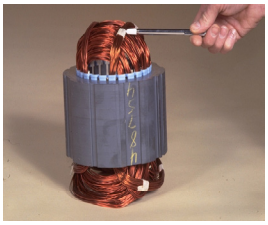
Professional Development Seminar Series – Engines & Alternators 54

Voltage & Excitation Control

- **What powers the voltage regulator?**
  - Shunt stator power
    - Tapping the main stator winding
  - Auxiliary stator winding
    - Improved performance
  - Chicken and egg problem
    - Field flashing



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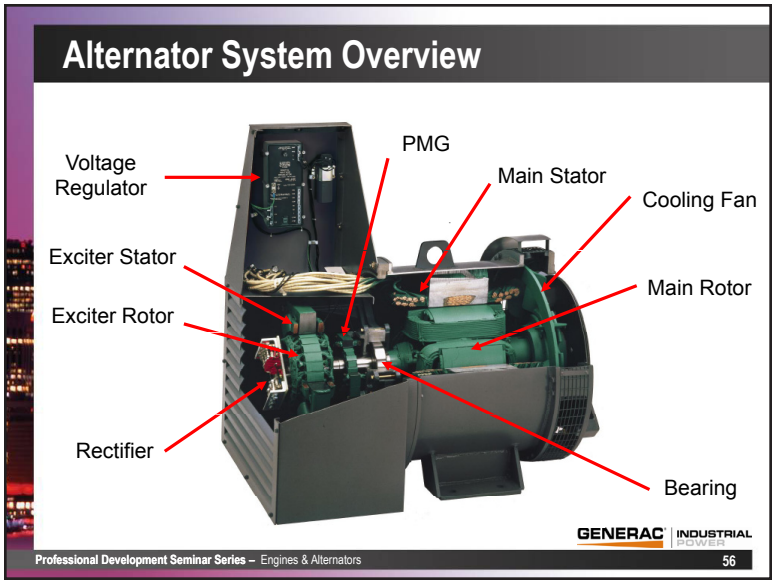
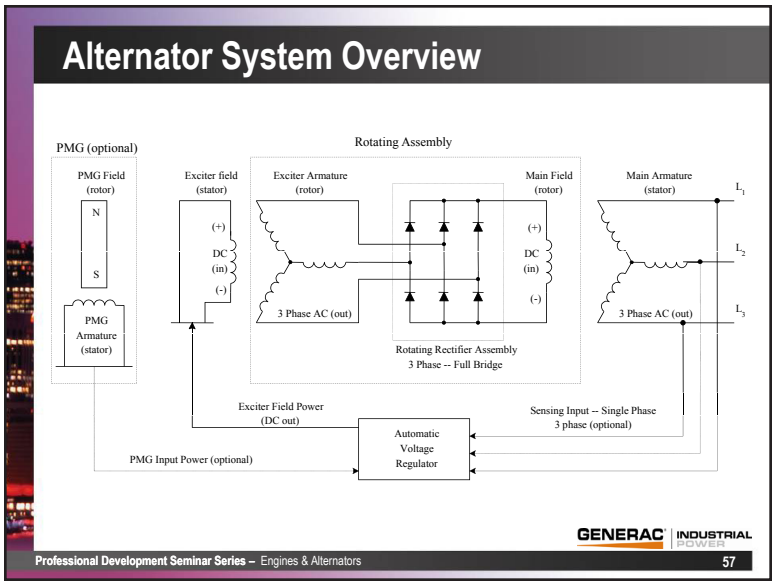
NOTES

3. ALTERNATORS





NOTES

Ratings & Performance

- **Temperature**
  - Class H materials (150°C R/R)
  - UL2200 limited to (120°C R/R) degree C
- **Harmonics** (typical values with linear load)
  - Distortion (< 5%)
  - TIF (<50)
- **Motor Starting** (reference manufacturers' charts)
  - Large voltage dips (alternator = Hp x 2)
  - Moderate voltage dips (alternator = Hp x 4)
  - sKVA versus voltage drop is generally linear
  - Performance at 120/208 typically reduced by 25% from 480V

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Professional Development Seminar Series – Engines & Alternators 58

Typical Alternator Data

Alternator Rating:

kW	kVA
832	1040

Part #.....0G6305 (R)
Type .....Brushless/PMG
Connections .....Series Wye
Efficiency @ 1.0 Power Factor

kW Load	Efficiency
150 kW	91.2
300 kW	92.4
600 kW	93.8
832 kW	94.2
832kW @ 0.8 pf	92.7

Machine Parameters @ Max kW Rating:

Transient S C Time Constant..... 1.7 ms
Subtransient Reactance..... 0.124
Transient Reactance..... 0.174
Synchronous Reactance..... 2.404
Negative Sequence Reactance 0.17
Zero Sequence Reactance 0.04
Short Circuit Ratio..... 0.35
Excitation Voltage 20-80V
Excitation Current @ Rated kW..... 3.2A -0.8pf
Lamination Type..... WEG

Waveform Distortion..... <5%
Telephone Influence Factor..... <50
Synchronous Speed..... 1800 rpm
Maximum Overspeed ..... 3300 rpm
Number of Bearings ..... 1-Sealed Ball
Insulation System ..... Class H
Excitation System.....Wound Field + Perm Mag

300% Current Limited

Temperature Rise vs. kW Output (0.8 PF):

kW	Temperature Rise ° C
653	80
777	105
832	125

Instantaneous Voltage Dip in kVA @ % Dip

Voltage	10%	15%	20%	25%	30%	35%
480 Volt	700	1100	1550	2100	2700	3200

Available Options:

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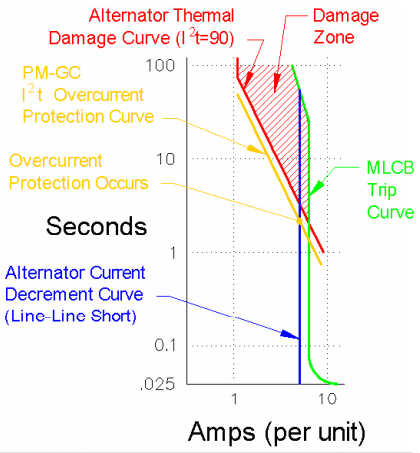
Professional Development Seminar Series – Engines & Alternators 59

NOTES

Protection

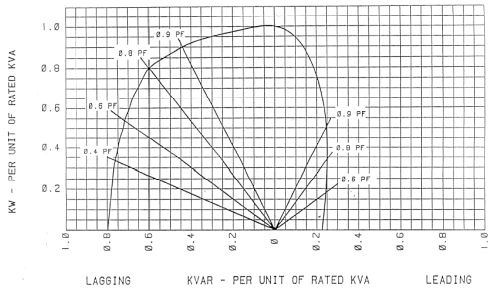
- **Overload**
  - Gensets are engine limited
  - Alarm at 90% load
- **Short circuit**
  - Generator breaker?
  - Field circuit breaker?
  - Control panel protection
  - Good installation practices



Professional Development Seminar Series – Engines & Alternators 60

Capability Curve – PF Limitations

- **Alternators are very limited with leading power loads**
  - Leading PF load current has a self excitation effect on the alternator
  - Voltage instability and over voltage shutdown are the failure modes
  - Shown here is a generic alternator capability curve



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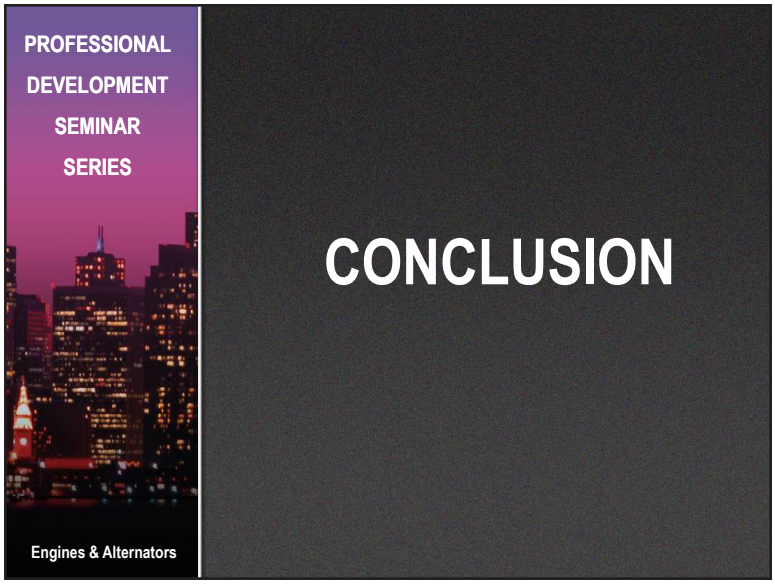
NOTES

CONCLUSION



NOTES

NOTES

Online Final Assessment

Final assessments are available for each PDSS session. These assessments are Web-based and can be accessed using Generac's online learning system *"The Learning Center"* (http:// learning.generac.com). PDSS participants are required to obtain a score of at least 80% to pass an assessment. Each online assessment also contains a training survey. The survey provides each participant an opportunity to rate various components of the learning experience along with information relative to business development. Instructions for how to register and log in to this system, take the final assessment and print a certificate, are described in the Registering in *"The Learning Center"* section below.

Continuing Education

Upon successful completion of a seminar, participants will be awarded 2.0 PDHs (Professional Development Hours) and 0.2 CEUs (Continuing Education Units). Successful completion of a seminar requires that the participant have:

- Attended the complete seminar
- Received a minimum score of 80% on the Final Assessment

Certificate of Accomplishment

Participants who successfully complete the seminar and receive a passing score on the online final assessment are entitled to a "Certificate of Accomplishment." Certificates are available for printing directly from the participant's account screen on Generac's online training system *"The Learning Center".* Instructions for how to register and log in to this system, take the final assessment and print a certificate, are described beginning in the following section.

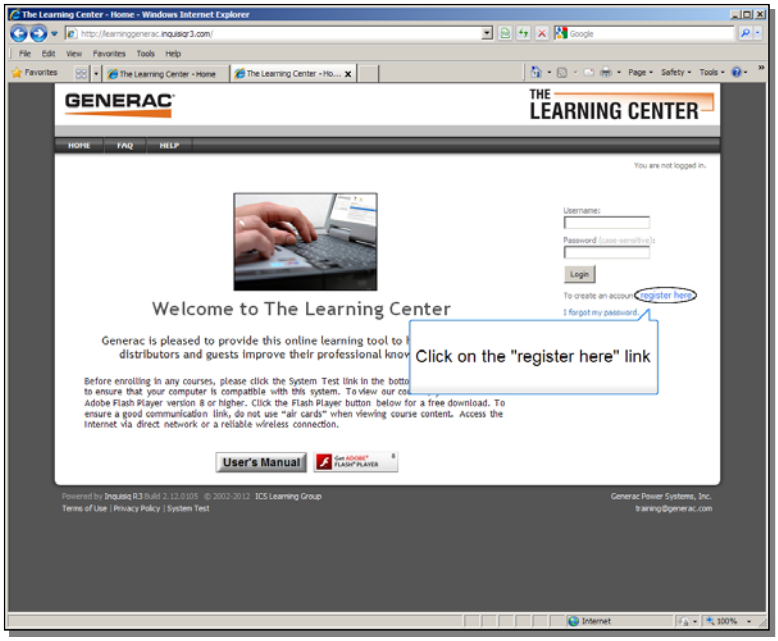
Registering in *"The Learning Center"*

To gain access to *"The Learning Center*", you are required to register and set up a user account. During your account setup you will create a *Username* and *Password*. Your username and password can then be used to log in on subsequent visits.

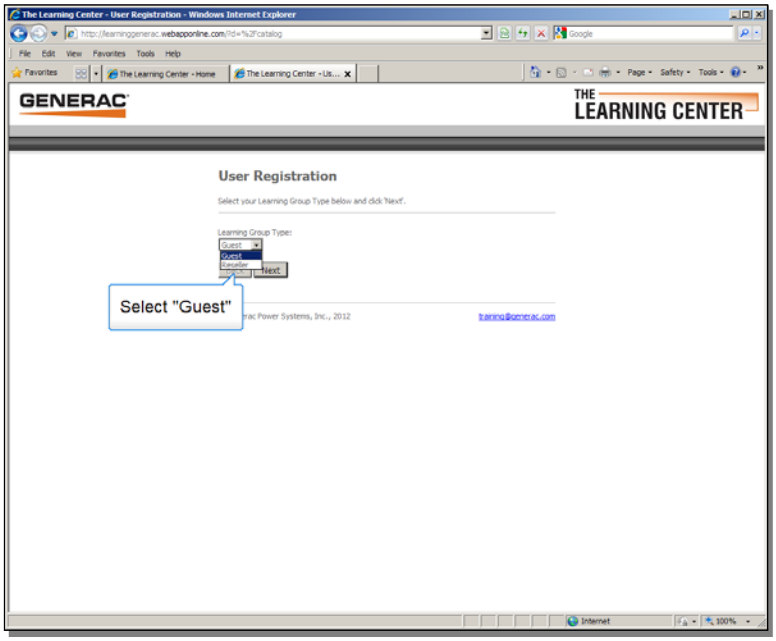
The following pages will aid you in the registration process along with the Final Assessment, Survey and Certificate procedures.

To begin the registration process, open your computer's browser and enter http:// learning.generac.com. This should take you to *"The Learning Center"* home page. This page is displayed at the top of the next page. From this point you can follow illustrated steps.

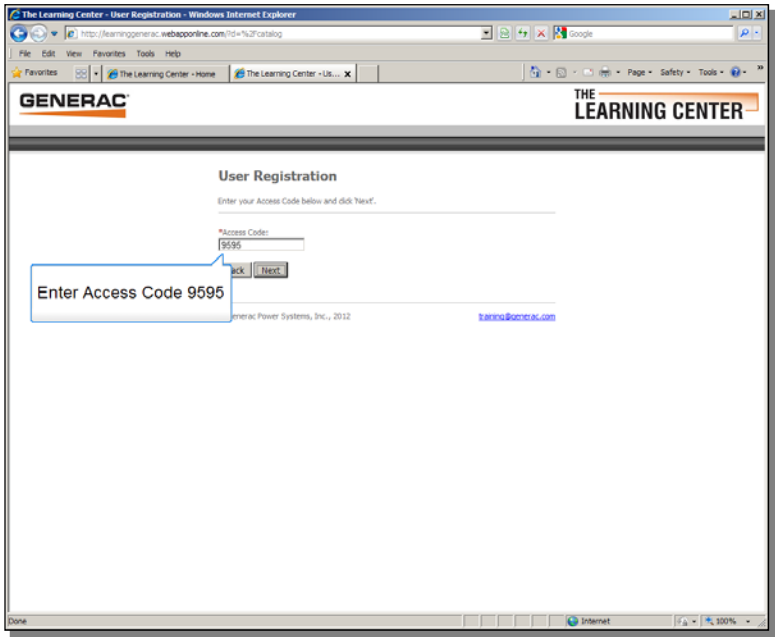
Begin by entering http://learning.generac.com in your computer's browser. The screen below will be displayed. Click on the "register here" link to begin the registration process.



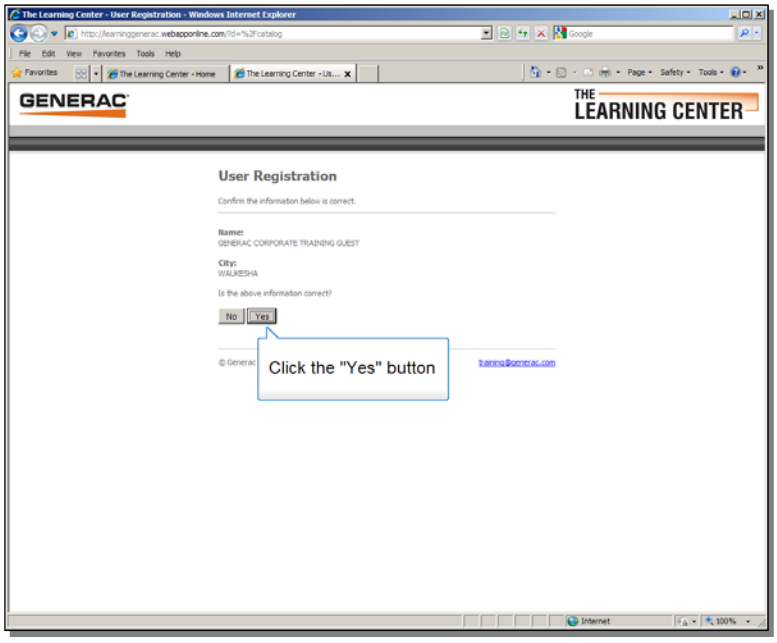
On this screen you will select "Guest" from the drop down box and click the "Next" button.



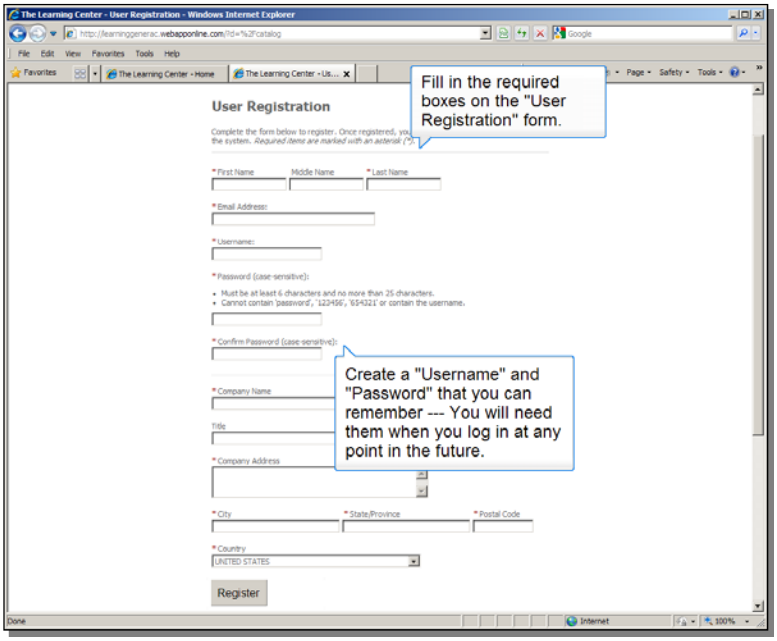
In this next screen enter **Access Code 9595** and click the “Next” button. Please keep this code private.



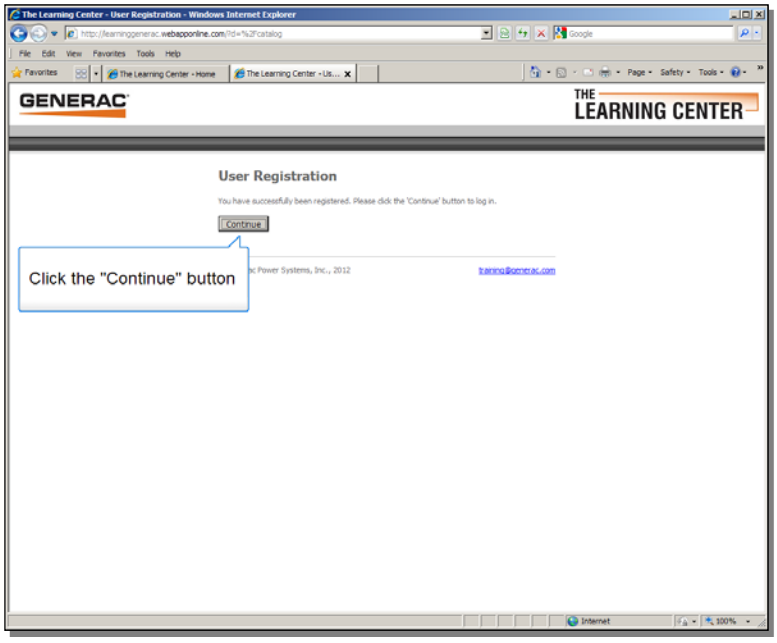
This screen confirms the correct access code entry. Click the “Yes” button to proceed.



The next screen contains the “User Registration” form. Fill in the required boxes, and then click the “Register” button.

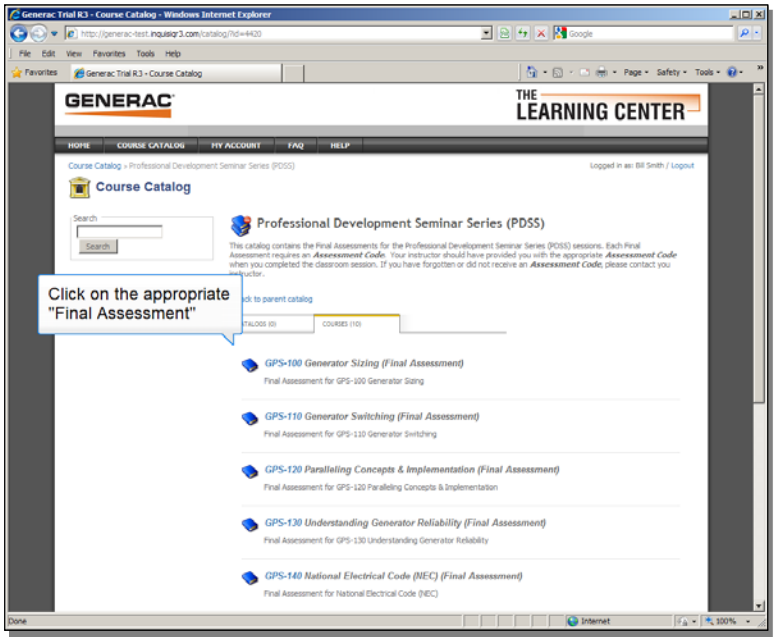


The next screen confirms your registration. Click the “Continue” button to proceed.

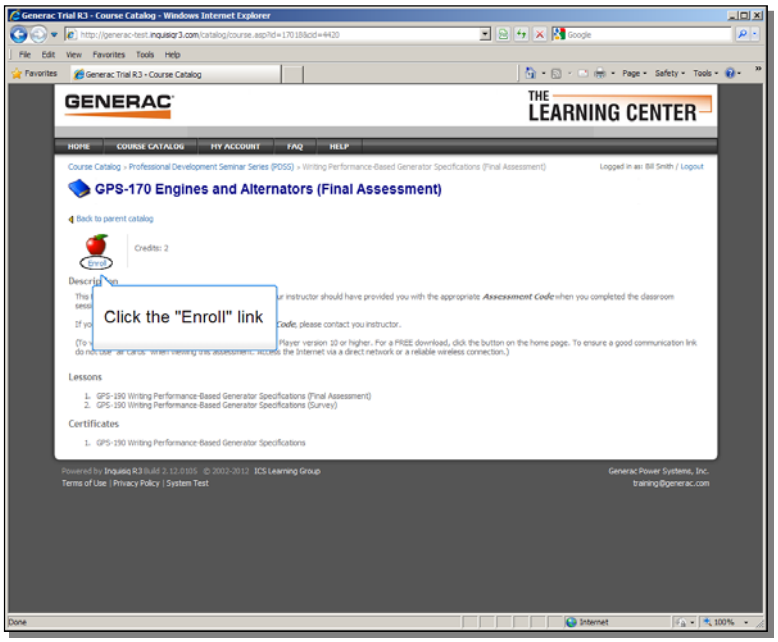


The next screen displays the “Course Catalog.” Click on the “Professional Development Seminar Series” link.

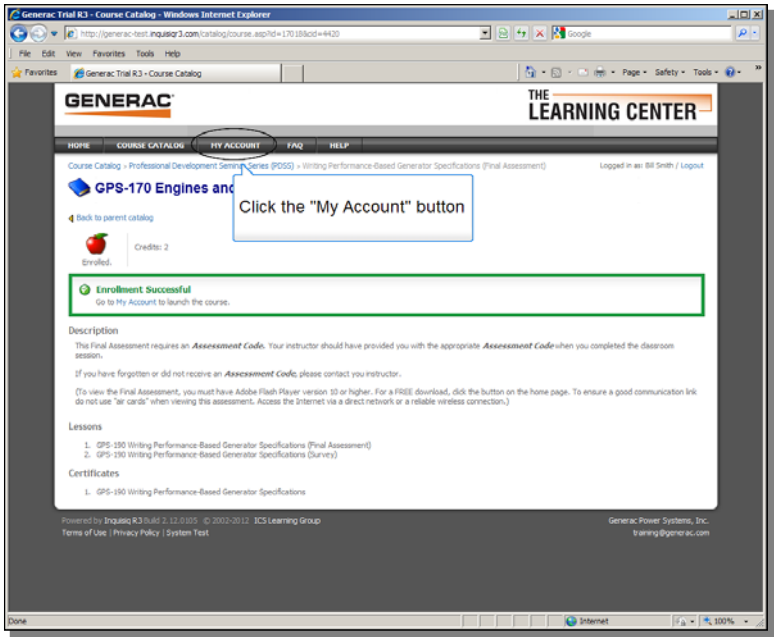
This next screen lists all currently available Final Assessments. Click on the Final Assessment that is tied to the course name and number you completed.



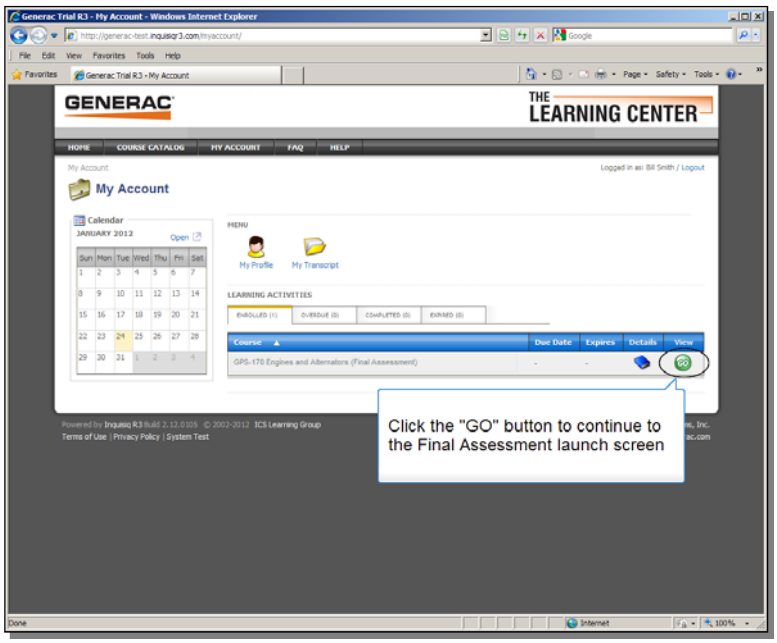
The next screen is the “Enrollment” screen for the Final Assessment that you selected. Click the “Enroll” link to proceed.



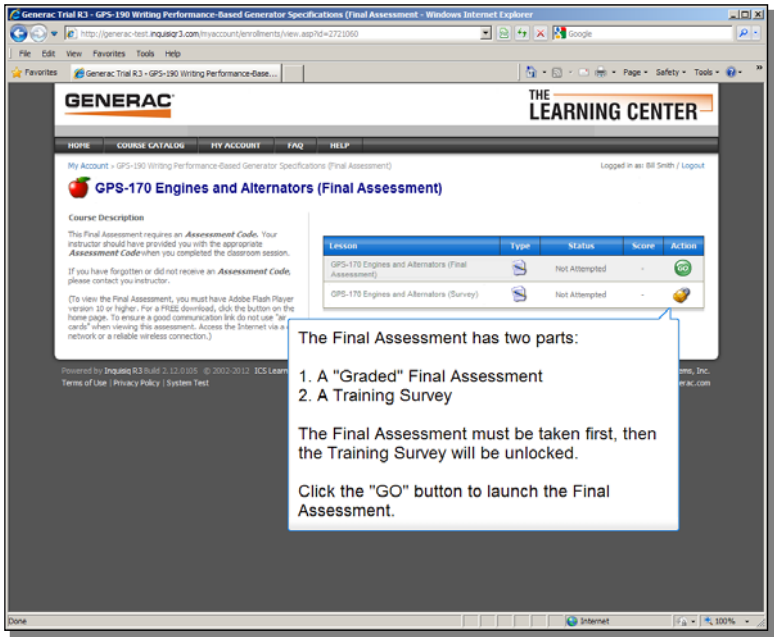
This screen confirms your enrollment. Click the “My Account” button to proceed.



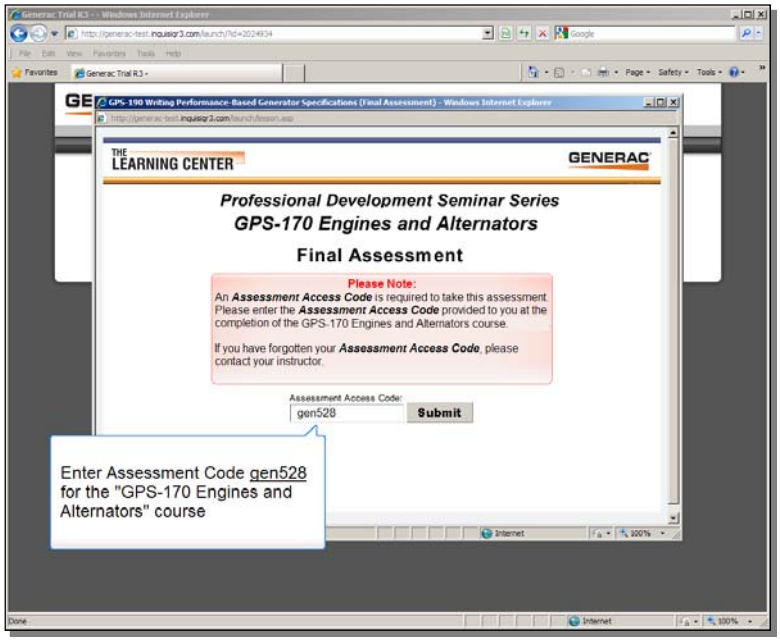
This is your “My Account” screen. Note that the Final Assessment you selected is displayed under the “Enrollment” tab. Click the “GO” button to proceed.



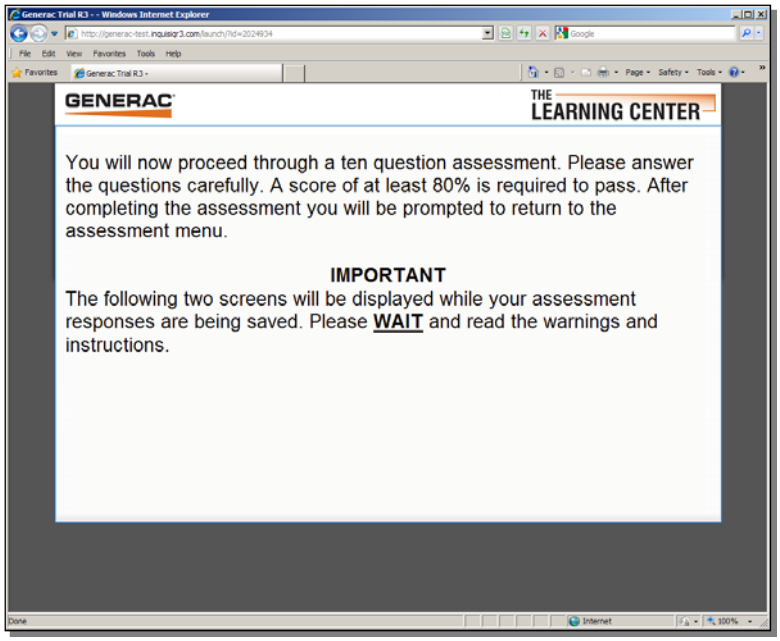
This screen lists the two parts to the Final Assessment. You must take the “Graded” Assessment first, then the Training Survey.



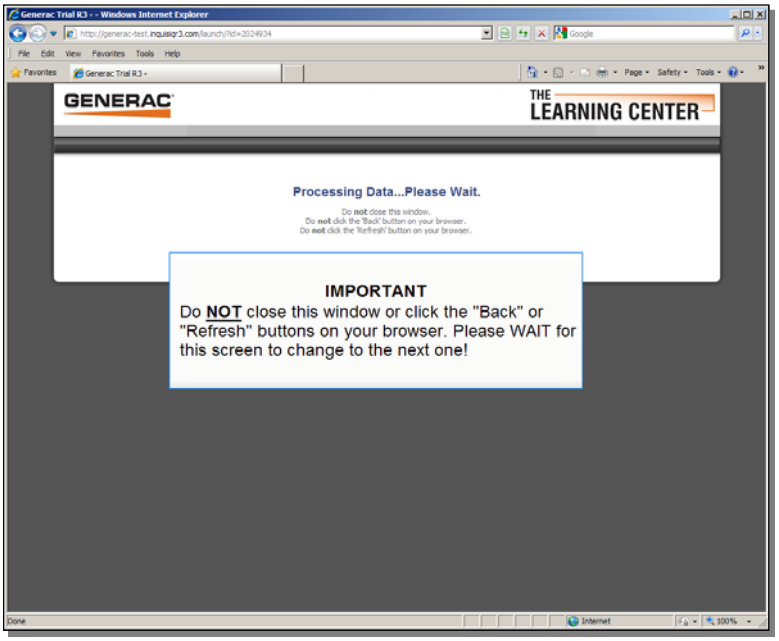
In the next screen an “Assessment Code” is required before you can continue. The code for GPS-170 Engines and Alternators is **gen528**. Enter the code in the box and click the “Submit” button to continue.



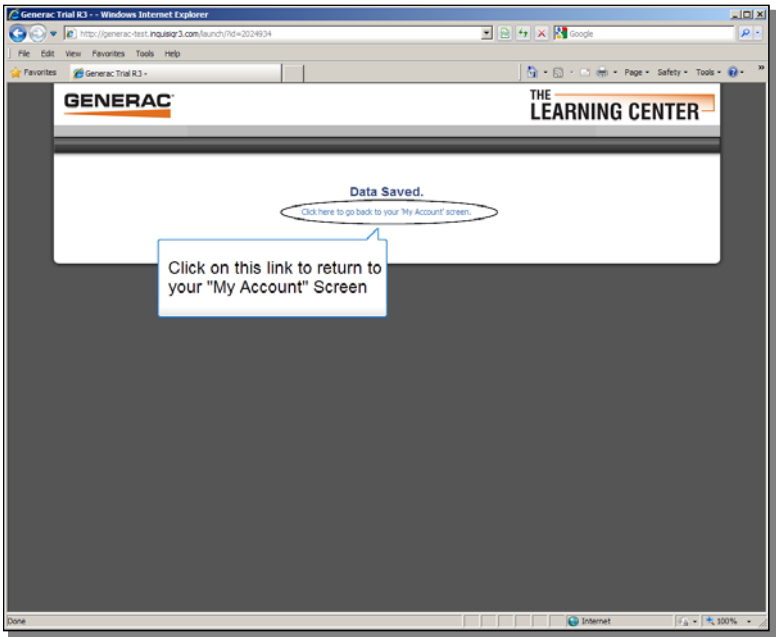
You will now proceed through a ten question assessment. Please read the warnings below.



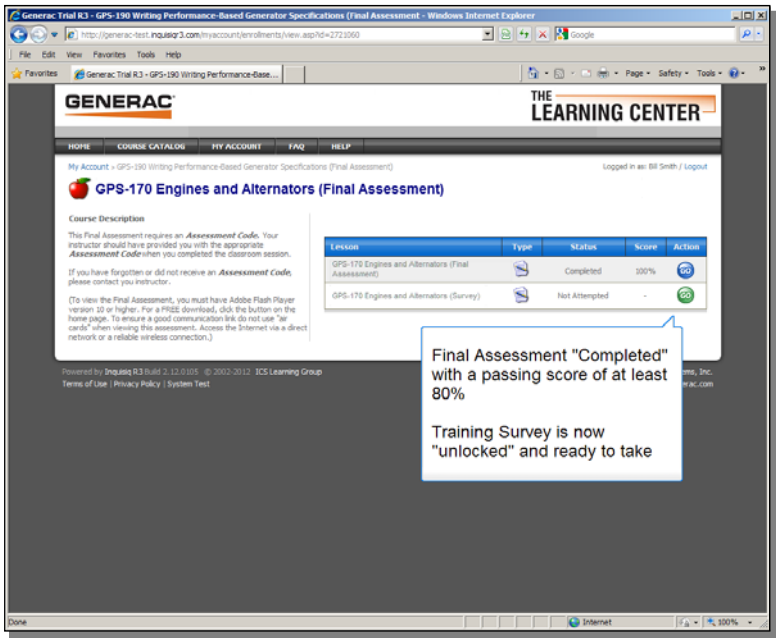
Please follow the instructions on this screen. You must wait for your assessment data to be saved. Do not close this window or click the 'Back' of 'Refresh' buttons on your browser.



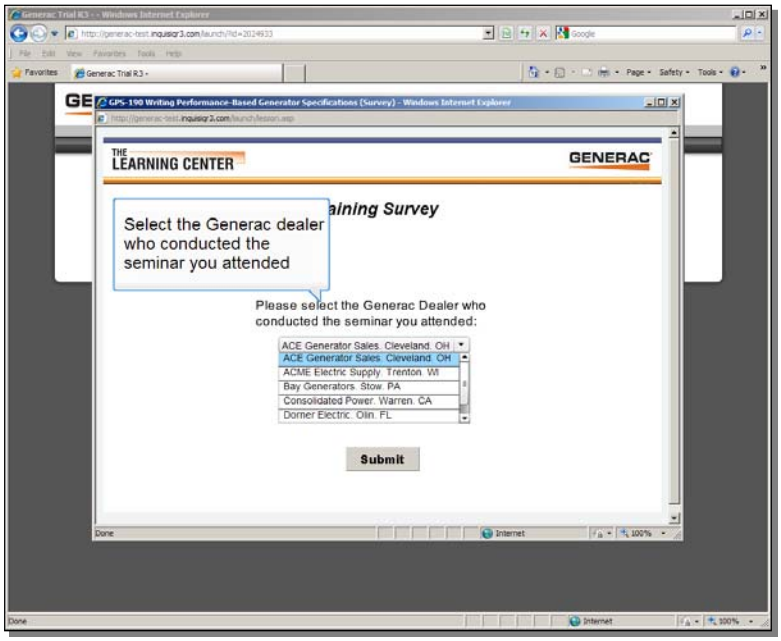
This screen confirms that your data was saved. Click on the link shown here to proceed.



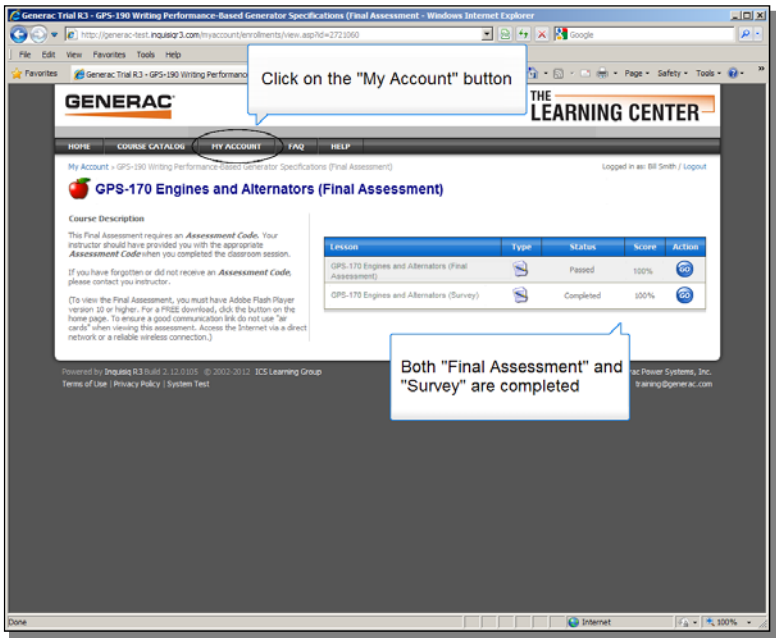
This screen will be displayed after your assessment data is saved. Note that in this example the assessment was passed with a score of 100% and the Survey is unlocked and ready to launch.



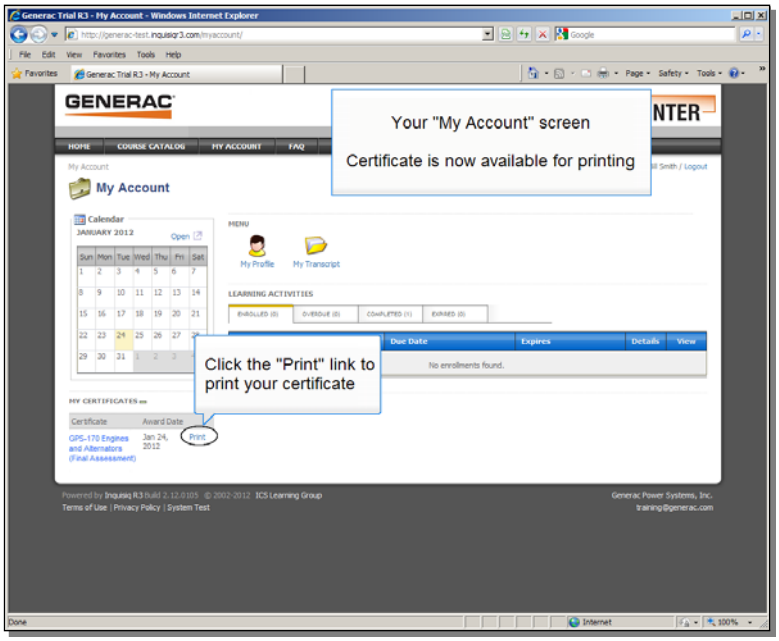
Upon launching the Survey, this screen will be displayed. Select the Generac dealer who conducted the seminar you attended.



After completing the survey you will be prompted to return to the assessment menu. Your response data will be saved as before, and you will see the screen below. Click the "My Account" button to continue.



Your "My Account" screen will look similar to the one shown here. Click the "Print" link to print your certificate.



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